Sustainable Management of Water Resources and Treatment Systems by Community Based Organizations in Sri Lanka

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Abstract: Water is a fundamental necessity for life, yet access to safe drinking water remains a significant challenge, particularly in rural areas of Sri Lanka. Recognizing these challenges, Sustainable Development Goal 6 emphasizes the need to ensure universal and equitable access to safe drinking water. In Sri Lanka, Community-Based Organizations (CBOs) are managing rural water supply schemes, providing water to thousands of households. This research focuses on the sustainability of water resource management and treatment systems in CBO-managed water supply schemes across Sri Lanka. For the study, a sample of 484 CBOs and 968 households was selected to collect data, and qualitative analyses were conducted to interpret the findings. The study reveals that only 53.8% of CBOs conduct routine water quality testing, while 17.9% of consumers express concerns about water quality, citing issues such as unusual colour (60.9%) and taste (39.1%). To ensure safe drinking water, many households rely on boiling (58.5%) and filtration (30.6%). Water accessibility remains a challenge, with 2.4% of households traveling over 2 km to fetch water, primarily on foot or by bicycle. Additionally, 50.8% of households spend over 30 minutes collecting water, which limits their access to safe drinking water. Furthermore, 16.9% of CBOs face inadequate water supply due to drought (50.6%), supply discontinuation (22.8%), high demand (15.2%), and low pressure (11.4%). As a result, 70.8% of households store water in plastic containers to manage supply uncertainties. This study highlights the key role of CBOs in ensuring safe drinking water in Sri Lanka. Key recommendations include addressing gaps in the study area, such as strengthening water quality testing, implementing Water Safety Plans (WSPs), and enhancing drought resilience strategies. Future research could explore barriers to WSP adoption, cost-effective filtration methods, natural purification techniques and AI-driven water quality monitoring for improved efficiency.

Key Words: Water Safety Plans, Water Accessibility, Water Quality Monitoring, Water Reliability, Safe Drinking Water

1. Introduction

Water is a fundamental human right, and addressing water scarcity and ensuring safe drinking water for all are critical concerns, with water quality being a key objective of Sustainable Development Goal 6. In many parts of the world,

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Community-Based Water Projects (CBWs), in collaboration with CBOs, do a great job in providing access to safe drinking water (Daluwatte & Sivakumar, 2018). These community-driven initiatives are essential for rural communities, where access to clean & reliable water sources may otherwise be limited. By empowering local communities, these projects contribute to improving public health and fostering sustainable water management practices, ensuring that people in rural areas can meet their daily water needs (Hussain, 2024).

In Sri Lanka has implemented community-based water projects for decades to provide safe drinking water to rural communities. Many of these projects were sponsored and funded by international organizations such as the Asian Development Bank, World Bank, DANIDA, and FINNIDA. However, by the 2010s, these projects faced the risk of becoming defunct due to various challenges. To address this, the government established the Department of National Community Water Supply (DNCWS) in 2014 to regulate community water projects and ensure their long-term sustainability. Currently, 3783 Community-Based Organizations (CBOs) are registered under the DNCWS, with most of these organizations relying directly on groundwater sources (Dissanayake & Ranasinghe, 2023).

Community-Based Organizations (CBOs) play a great role in ensuring the sustainability of water supply schemes by effectively fulfilling their responsibilities. The activities of these organizations serve as the primary, foundational, and most significant source of access to quality water and the long-term viability of community water projects. Through active community involvement in the planning, implementation, and management of water resources, CBOs help to ensure that water systems are maintained, accessible, and reliable for the communities they serve. Their efforts are vital to promoting the continued success and sustainability of water initiatives (Alam, 2022).

Community-Based Organizations (CBOs) registered with the DNCWS, currently provide water coverage to approximately 11% communities in Sri Lanka. However, some of these CBOs face significant challenges related to the quality of the water they supply. In certain areas, the water is not safe for drinking due to contamination, particularly in shallow wells, which have been adversely affected by climate change, increased demand, and seasonal droughts in the regions. (Riswan & Ishaq, 2020).

This issue is largely driven by a lack of awareness among CBO members about water quality standards, as well as the absence of proper laboratory facilities for conducting essential water quality tests. As a result, the water provided may not consistently meet health standards, potentially compromising both the drinking water needs and the overall health of the communities they serve. To address these challenges, the implementation of a capacity-building

program is essential. Providing support services, at least in the short term, is crucial for enhancing the capabilities of Community-Based Organizations (CBOs) and empowering them to become more effective, self-sustaining, and mature entities (Mimrose et al., 2012).

Introduced in the third edition of the WHO Guidelines for Drinking-Water Quality in 2004, WSPs provide an internationally recognized framework for systematically managing risks to improve water quality. (Herschy, 2012). While WSPs have become widely accepted in managing drinking water systems, their adoption remains limited in developing countries, where the need for improved water quality is particularly critical (Alazaiza et al., 2022). It acknowledges the importance of teamwork, substantial investment, and the commitment of multidisciplinary professionals, which are crucial for the successful implementation of effective water safety plans and the long-term sustainability of water quality improvements. However, challenges such as limited resources, lack of technical expertise, and inadequate infrastructure hinder widespread adoption, making it crucial to address these barriers for improved water safety and health outcomes. (Ezenwaji & Phil-Eze, 2014).

This research fills a significant empirical gap in the existing literature by examining the sustainability of water resources and treatment systems managed by Community Based Organizations (CBOs) in Sri Lanka. By gathering primary data from both the CBOs and the consumers they serve, the study offers valuable insights into the practical challenges and successes in managing water quality, accessibility, and supply reliability. Understanding these factors is crucial for improving the long-term sustainability of community-managed water systems and ensuring the provision of safe, reliable water services. The study aims to evaluate the sustainability of water resources and treatment systems managed by CBOs in Sri Lanka, focusing on three key aspects: water quality monitoring, water accessibility, and water supply reliability. These factors are essential in determining the effectiveness of CBOs in providing safe drinking water and equitable access to water resources.

To achieve this objective, the study is structured around three specific research aims: (1) evaluating the effectiveness of regular water quality monitoring in ensuring safe drinking water, (2) examining the accessibility of water resources for communities served by CBOs, and (3) assessing the reliability of water supply systems managed by CBOs.

A conceptual framework was developed to explore the relationships between key variables.

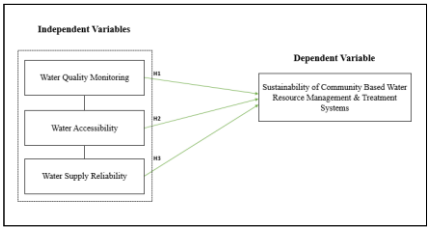

Figure 1: Conceptual Framework

The framework includes three independent variables water quality monitoring, water accessibility, and water supply reliability and one dependent variable, the sustainability of community-based water resource management and treatment systems. This framework serves as the basis for testing the study's hypotheses and analysing the factors influencing the sustainability of CBO-managed water systems.

From this conceptual framework, three hypotheses were formulated to explore the relationships between the independent and dependent variables. The first hypothesis (H1) proposes that the regularity of water quality monitoring significantly influences the perception of safe drinking water among CBO communities. The second hypothesis (H2) suggests a significant relationship between water accessibility and overall water satisfaction in CBO-managed communities. The third hypothesis (H3) asserts that the reliability of the water supply system is significantly associated with water supply satisfaction in CBO-managed communities.

These hypotheses provide a structured approach to investigating the key factors that impact the sustainability of community-based water management systems.

2. Materials & Methods

The primary data was collected from Community-Based Organizations (CBOs) operating across all 25 districts of Sri Lanka. A total of 484 CBOs participated in the study, out of the 3,783 actively engaged CBOs registered with the DNCWS. Additionally, 968 CBO households participated, representing a subset of the 604,981 beneficiary households. During the data collection process, 242 DNCWS field officers from all 25 districts contributed to gathering real-time data from the field. To facilitate data collection, separate questionnaires were designed for CBOs and Household respondents, available in both Sinhala and English languages.

Secondary data was obtained from various sources, including articles, books, and Key Performance Reports published by the DNCWS.

Key topics discussed in the interviews included in CBOs: Water sources, Treatment units, Storage systems, Pumps and distribution systems, Water quality and management procedures, Historical records of operations and maintenance. This information was critical in assessing potential risks and identifying areas for improvement in CBO-managed water supply systems.

A questionnaire was developed for consumers included information on the respondents' personal profiles, primary drinking water sources, alternative domestic water supply sources, and their level of satisfaction with water supply (in terms of both quality and quantity), water supply patterns, household storage systems and treatment methods practiced.

The questionnaires were administered to 968 consumers, covering the entire country. Consumers and Community-Based Organizations (CBOs) in each district were randomly selected using Purposive Sampling Technique. Two house holders selected for one CBO and one household member was selected to respond to the questionnaire. If the selected respondent could not read or write, the questions were administered in a language they understood, and their responses were recorded accordingly.

In this study, qualitative statistical data analysis was employed to analyse the collected data. The analysis was primarily focused on identifying patterns, trends, and relationships within the data. Various graphs and charts were used to visually represent the findings, helping to clearly illustrate the distribution and variation of the data. Additionally, percentages were calculated to provide a clearer understanding of the proportions and comparisons within different categories. These visual tools allowed for an effective presentation of the results, facilitating the interpretation of complex data in a comprehensible manner.

3. Results & Discussion

This study focuses on Community-Based Organizations actively operated with the Department of National Community Water Supply in Sri Lanka. As of the most recent data, currently there are 3,783 active CBOs regulated by the DNCWS.

Due to practical constraints related to time, resources, and accessibility, a sample of 484 CBOs was selected for the study, representing a portion of the national population. Furthermore, the study involved 968 beneficiary households selected from a total of 604,981 households (H/H) within these CBOs.

Additionally, while the sample size is significant, it may not fully represent the diversity and complexity of all CBOs across Sri Lanka, particularly those in remote or less accessible regions.

3.1 Water Quality Monitoring

While many people are generally satisfied with the quality and taste of their community water supply, despite these efforts, 17.9% of consumers still express concerns about water quality, with the most common issues being unusual colour (60.9%) and taste (39.1%).

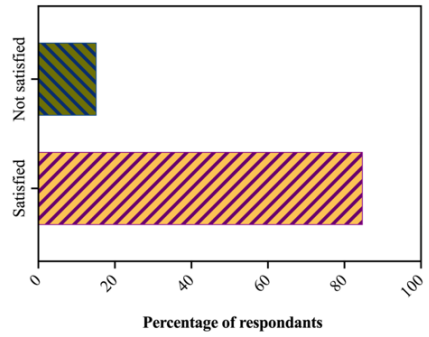

Figure 2: Water Quality satisfaction by consumers

The study reveals that only 53.8% of Community-Based Organizations

(CBOs) conduct routine water quality monitoring. To ensure safe drinking water, many households use boiling (58.5%) and filtration (30.6%) as additional treatment methods.

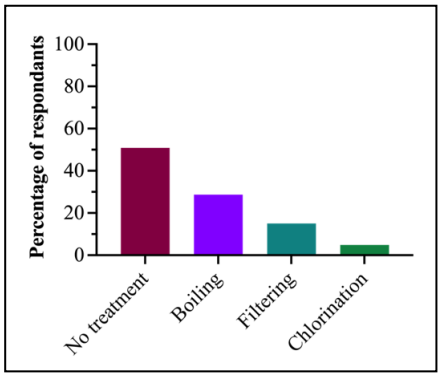

Figure 3: Home water treatment practices by consumers.

The hypothesis (H1) that the regularity of water quality monitoring significantly impacts the perception of safe drinking water is supported by these findings, as inadequate monitoring can lead to uncertainty and dissatisfaction among consumers.

Strengthening regular Water Quality Testing ideally at least every six months is essential for maintaining water safety, reducing contamination risks, and improving community trust in CBO managed water systems. Additionally, implementing the Water Safety Plan (WSP) and increasing Awareness programs are crucial for enhancing consumer confidence and reducing reliance on household water treatment methods.

3.2 Water Accessibility

Water accessibility remains a significant challenge for communities as consumers must travel long distances to collect water. The study indicates that 2.4% of households must transport water over distances exceeding 2 kilometers, primarily on foot or by bicycle. Additionally, 50.8% of respondents spend more than 30 minutes collecting water, which severely limits their access to safe and sufficient drinking water.

These results support the hypothesis (H2) that there is a significant relationship between water accessibility and overall water satisfaction in CBO-managed communities. Addressing infrastructure limitations like improving Water Distribution Networks implementing Decentralized water access points are crucial steps in ensuring equitable and reliable access to safe drinking water.

3.3 Water Supply Reliability

The study identifies 16.9% of CBOs experiencing an inadequate water supply, affecting their ability to consistently meet community needs. The primary causes of supply disruptions include drought-related shortages (50.6%), supply discontinuation (22.8%), high water demand (15.2%), and insufficient water pressure (11.4%). The study found that 70.8% of households rely on plastic containers for water storage as a direct response to supply uncertainties.

The findings support the hypothesis (H3) that the reliability of the water supply system significantly affects consumer satisfaction in CBO-managed communities. Ensuring a stable and reliable water supply requires targeted interventions, including improved Storage Capacity, enhanced Drought Resilience Strategies, and better Water Management practices.

4. Conclusion

This study underscores the crucial role of CBOs in providing safe drinking water in Sri Lanka. Based on the findings, several recommendations can be made to address gaps in the study area.

These include strengthening regular water quality testing and implementing Water Safety Plans (WSPs) to ensure consistent monitoring and management of water quality. Additionally, addressing infrastructure limitations is essential, such as improving water distribution networks and implementing decentralized access points to enhance accessibility. Furthermore, enhancing drought resilience strategies and promoting effective water management practices will help sustain water resources in the long term.

This study also opens avenues for future research. Potential areas of exploration include identifying barriers to WSP adoption in CBO-managed systems and researching cost-effective filtration and treatment methods suitable for rural communities. Additionally, future studies could explore the use of natural purification techniques, such as bio-sand filters and solar disinfection, as well as assess the potential of AI-driven water quality monitoring to enhance efficiency and accuracy in water management.

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